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Targeting hardcore smokers: The effects of an online tailored intervention, based on motivational interviewing techniques

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ABSTRACT

Objectives: Hardcore smokers have smoked for many years and do not intend to quit. They also seem unreceptive to information about smoking cessation. We developed a 30-min, tailored web-based intervention that includes motivational interviewing principles. It aims to increase hardcore smokers' intention to quit and their receptivity to information about smoking cessation.

Design: In a two-arm experiment, we compared outcome scores of the experimental intervention (n = 346) with those of a control intervention (n = 411).

Methods: Our main outcomes were receptivity to information about quitting, intention to quit, quitting self-efficacy, and interest in a subsequent online intervention. Our secondary outcomes were cigarettes smoked per day and quit attempts. All outcomes were measured directly post-experiment (t_1), after 2 weeks (t_2), and after 2 months (t_3).

Results: At t_1, hardcore smokers in the intervention condition were more receptive to information about quitting than controls. At both t_2 and t_3, those in the experimental group had reduced the number of cigarettes more than those in the control group. At t_2, but not t_3, more participants in the experimental group had reduced their cigarette consumption by at least 50% than among controls. We found no significant differences in intention to quit, quitting self-efficacy, interest in a subsequent online quitting intervention, and number of quit attempts.

Conclusions: The intervention increased hardcore smokers' receptivity to information about smoking cessation and decreased their cigarette consumption by

about 1 cigarette per day. Although the results are positive, the clinical relevance may be limited. We recommend further developing this intervention for practical use in health care settings.

STATEMENT OF CONTRIBUTION

What is already known on this subject?

- Hardcore smokers have smoked for many years and do not intend to quit.
- There are currently no online interventions for hardcore smokers.

What does this study add?

- This study tested an online intervention for hardcore smokers.
- The intervention increased hardcore smokers' receptivity to information about quitting.
- It also helped to reduce the number of cigarettes per day.

BACKGROUND

Smoking is one of the leading causes of death and disease in the world (WHO, 2011). It is therefore imperative to find ways to promote smoking cessation. One group, the so-called hardcore smokers, seem particularly unlikely to quit smoking (Warner & Burns, 2003). Hardcore smokers are people who have smoked for many years and have no intention-to-quit smoking (Costa *et al*., 2010). In 2012, 32% of Dutch smokers could be considered 'hardcore', which equals to 8% of the Dutch general population (Bommelé *et al*., 2016). Compared to non-hardcore smokers, they have lower quitting self-efficacy (Sorg, Xu, Doppalapudi, Shelton, & Harris, 2011) and tend to have dysfunctional beliefs about smoking (Bommelé *et al*., 2014). Dysfunctional beliefs are beliefs that prevent smokers from quitting, such as perceived benefits of smoking and perceived costs of quitting. As hardcore smokers have more such beliefs than non-hardcore smokers (Jarvis, Wardle, Waller, & Owen, 2003), they may be particularly irresponsive to tobacco control interventions. Whereas many web-based smoking interventions have been developed for the general population (Civljak, Stead, Hartmann-Boyce, Sheikh, & Car, 2013; Lemmens, Oenema, Knut, & Brug, 2008; Walters, Wright, & Shegog, 2006), no online interventions have been specifically developed for hardcore smokers. As hardcore smokers seem resistant towards information about quitting, it may be particularly difficult to convince them to quit smoking (Bommelé *et al*., 2015b; Warner & Burns, 2003). As they might be unwilling to consider quitting, they need to become more open towards antismoking messages first (Prochaska & DiClemente, 1982, 1983). We therefore developed and experimentally tested an intervention that aims to increase hardcore smokers' willingness to read such tobacco control messages. The intervention also aims to increase hardcore smokers' intention-to-quit smoking, quitting self-efficacy, receptivity to information about quitting, and interest in a subsequent online intervention.

Increasing receptivity to information about quitting

The first intervention component aimed to increase receptivity to antismoking information. According to the self-affirmation theory, everyone is motivated to perceive himself as a moral and competent person, who acts according to moral norms or his or her personal values (Steele, 1988). This sense of self-integrity may be threatened by health messages, because such messages suggest that smokers act

inconsistently with personal or moral norms about healthy lifestyles (Harris & Epton, 2009, 2010). Smokers therefore avoid or discard such antismoking messages. Self-affirmations tackle such defensive responses to a threatening message (Epton, Harris, Kane, & Van Koningsbruggen, 2015a; McQueen & Klein, 2006). Self-affirmations are positive reinforcements in another domain than the threatening message (i.e., other than smoking). They are believed to distract the self away from the loss of self-integrity. To tackle defensive responses in our intervention, we included the kindness questionnaire as a self-affirmation manipulation (Reed & Aspinwall, 1998). In a previous study, we found that this manipulation is suitable for hardcore smokers (Bommelé *et al*., 2015b).
We used two other techniques to further increase receptivity to the messages in the intervention. First, we tailored responses of the digital trainer to participants' responses. Tailoring has been shown to increase the effectiveness of online interventions (Shahab & McEwen, 2009). Second, we incorporated motivational interviewing techniques (Miller, 1983). Motivational interviewing has been used effectively in clinical settings (Lai, Cahill, Qin, & Tang, 2010) and in another online intervention (Friederichs *et al*., 2014).

Increasing intention to quit

Intention-to-quit smoking is a major predictor of quit attempts (Vangeli, Stapleton, Smit, Borland, & West, 2011). Its importance has been emphasized by the Health Belief Model (Rosenstock, Strecher, & Becker, 1988) and the Reasoned Action Approach (Fishbein & Ajzen, 2010). To increase intention-to-quit smoking, we developed one intervention component that aimed to improve attitude towards quitting (second intervention component) and one component that increases quitting self-efficacy (third intervention component). Attitude towards quitting and quitting self-efficacy are two determinants of intention to quit (Ajzen, 1991; Bandura, 1977; Fishbein & Ajzen, 2010; Rosenstock *et al*., 1988), and both were important self-reported determinants of smoking cessation in two previous studies among hardcore smokers (Bommelé *et al*., 2014, 2015a,b).
The second intervention component aimed to improve attitude towards quitting by changing dysfunctional beliefs about smoking and quitting. In line with the Intervention Mapping protocol – a protocol for developing interventions – (Bartholomew, Parcel, & Kok, 1998; Bartholomew, Parcel, Kok, Gottlieb, & Fernández, 2011), we selected a set of specific outcome beliefs from a previous focus group study on hardcore smoking (Bommelé *et al*., 2014). In that study, we identified six themes among hardcore smokers' perceived pros and cons of smoking and quitting. We used these themes as topics for this second intervention component. As hardcore smokers tend to perceive more pros of smoking and more cons of quitting than non-hardcore smokers (Bommelé *et al*., 2015a), it emphasized the cons of smoking and the pros of quitting.

Increasing quitting self-efficacy

The third intervention component aimed to increase quitting self-efficacy. Self-efficacy is theorized as a prerequisite of change in intention and behaviour (Ajzen, 1991; Bandura, 1977). Quitting self-efficacy is especially important for hardcore smokers, as they tend to have a lower quitting self-efficacy than non-hardcore smokers (Bommelé *et al*., 2015a; Sorg *et al*., 2011). Using the Intervention Mapping protocol (Bartholomew *et al*., 1998, 2011), we developed four video clips in which

ex-smokers explained how they coped with difficult situations after quitting. In this third part of the intervention, participants viewed these video clips and elaborated on how they would cope with such difficult situations themselves.

Current study

We tested a tailored, web-based intervention for hardcore smokers. In a two-arm experiment, we compared outcome scores of the experimental intervention with those of a control intervention. Our main outcomes were receptivity to information about quitting, intention to quit, quitting self-efficacy, and interest in a subsequent online intervention. Our secondary outcomes are cigarettes smoked per day and quit attempts.

METHODS

Participants

Participants were recruited via an online panel (Survey Sampling International), which has about 11.5 million panellist in 103 countries. In the description of the study, we stressed that we were interested in their opinion about smoking only. We also emphasized that we would not judge their opinion and that they did not have to quit smoking during the study. We used a screener questionnaire to identify eligible Dutch hardcore smokers. Smokers were 'hardcore' if they (1) were 25–65 years old, (2) smoked every day, (3) smoked 15 cigarettes per day or more, (4) had no quitting attempt in the past 12 months, (5) had smoked 5 years or more in life, and f) had no intention to quit within 6 months (Bommelé *et al*., 2014, 2015a,b). We chose a definition that was most similar to most of the definitions that exist in the literature. This way, the results from our study could be compared to the findings of others. In line with previous research, we did not include participants younger than 25 years, because people under 25 may not have reached a stable cigarette consumption and may have less stable intentions regarding quitting (Emery, Gilpin, Ake, Farkas, & Pierce, 2000). As people older than 65 are harder to recruit than younger people, we did not include people older than 65 years.

The screener questionnaire included the criteria above (including t_0-measurements of cigarettes per day). It also assessed participants' sex and used their highest attained level of education to determine their socio-economic status (SES). Low SES participants had primary education, lower secondary education, lower vocational education, or middle vocational education. High SES participants had higher secondary education or tertiary education. Sex and education are important predictors of hardcore smoking (Emery *et al*., 2000; Ferketich *et al*., 2009). To control for potential biases due to these variables, we used a randomized stratification method (Suresh, 2011). Within each demographic group (i.e., low SES men, high SES men, low SES women, high SES women), participants were alternately allocated to one of the two conditions (i.e., the first low SES man received the experimental intervention, the second one the control intervention, the third one the experimental intervention). As participants could start the study at a time of their convenience, a near-random allocation to conditions was established within each stratified group. Participants were blinded to conditions other than their own. They completed the intervention in October 2014, and we collected follow-up data in November and December 2014.

The ethics committee of the Faculty of Social Sciences at the Radboud University Nijmegen approved the study's protocol (ECG2013-1308-119a).

Procedure

Directly after the screener questionnaire (t_0), 1362 hardcore smokers were allocated to one of the two conditions (intervention vs. control), stratified by sex and SES.

Of 1362 hardcore smokers allocated, 1090 signed informed consent and 931 completed the demographics (t_0). Please note that the baseline measurements (t_0) included both the screening questionnaire and the pre-intervention demographics. A total of 780 hardcore smokers completed the intervention itself and 757 finished the post-test measurements (t_1). Those who finished the post-test measurements were invited for follow-up. Participants completed one follow-up after 2 weeks (t_2: n = 599) and one after 2 months (t_3: n = 519). Figure 1 shows the recruitment process throughout the study.

[FIGURE 1]

Intervention

The intervention (i.e., 'smoke experts.nl', in Dutch: 'rookexperts.nl') consisted of three components and took about 30 min to complete. We pre-tested the intervention for readability and comprehensibility in two focus groups among hardcore smokers. Throughout the intervention, participants were assisted by a virtual online character called 'Kees' (a common given name in the Netherlands). Kees represented himself as a digital trainer who was interested in the participants' opinion as smoke experts. Participants knew the trainer was not a real person. However, to make the digital trainer as realistic as possible, we showed several photographs of him throughout the intervention and composed the text in the intervention in such a way that it seemed as if he was interviewing the participants.

The first intervention component aimed to increase receptivity towards quitting. In this component, participants completed the kindness questionnaire (Reed & Aspinwall, 1998), a self-affirmation task designed to tackle smokers' defensive responses to antismoking messages (Armitage & Rowe, 2011; Bommelé *et al*., 2015b). The kindness questionnaire contains 10 items asking whether participants have ever performed acts of kindness to others (yes/no). We also asked to elaborate on some of these past acts of kindness.

The second intervention component aimed to increase intention to quit. Participants and the trainer discussed several smoking-related topics, such as the health effects of smoking, the effect of smoking on social relations, and the money potentially saved by quitting. With each topic, the trainer first assessed whether participants had dysfunctional beliefs about that topic by presenting a number of potential dysfunctional beliefs himself and asking participants to indicate whether they agreed with them or not. If they did, the trainer presented a text or video clip that countered specific those beliefs. As such, the trainer gave feedback that was tailored to the specific beliefs participants had. While discussing money, for example, the trainer asked participants who did not believe quitting would save money to calculate how much money they could save by quitting. He also asked them how they could spend that money.

The third intervention component aimed to increase quitting self-efficacy. Participants and the trainer discussed four general types of barriers to quitting: smoking-related habits, unsupportive others, stressful situations, and cravings. For each type, participants imagined they had quit smoking and encountered four specific situations. There were 16 situations in total. When discussing smoking-related habits, for example, participants discussed four situations in which smoking-related habits could lead to relapse: waking up, drinking coffee, having diner, and having a break. If participants indicated that remaining abstinent in one or more of those situations would be difficult, the trainer presented a video clip in which an ex-smoker explained how to deal with these specific situations. Previous studies have used similar 'tailored testimonials' before (McClure *et al*., 2014).

Control intervention

The control intervention was similar to the intervention layout and length, but contained bogus components. The first component did not include questions about kindness, but about everyday events (e.g., using public transport or reading a book). The second component did not discuss quitting smoking, but discussed the history of tobacco. The third component did not discuss barriers to quitting, but discussed the cultivation of tobacco. The control intervention included no tailored messages, no motivational interviewing techniques, and no self-affirmation manipulation.

Demographics and main outcomes

At the start of the experiment (t_0), we measured basic demographics (age, sex, education), smoking-related demographics (cigarettes per day, years smoked in life), and the Fagerström Test for Nicotine Dependence (Heatherton, Kozlowski, Frecker, & Fagerström, 1991).

Main outcomes

We measured our main outcomes directly after the intervention (t_1), after 2 weeks (first follow-up: t_2), and after 2 months (second follow-up: t_3). As the main outcomes were quite lengthy, we did not measure them at baseline (t_0). Including them at baseline would have increased dropout rates early in the study. Also, the responses given at baseline might have served as an anchor and would have influenced participants' answers on the post-test questions (t_1).

Receptivity to quitting information

Receptivity to information about quitting was measured with a four-item questionnaire. Example items were as follows: 'I am willing to think about smoking cessation', 'I would like to think carefully about smoking cessation', 'I would like to know more about smoking cessation', and 'Right now, I would like to read something about smoking cessation.'

Intention to quit

We measured intention to quit using a three-item questionnaire. The items were as follows: 'I intend to quit smoking someday', 'I will quit smoking in the future', and 'I will quit smoking someday'.

Quitting self-efficacy

We measured quitting self-efficacy using a three-item questionnaire. These items were as follows: 'I am able to quit smoking', 'I would be able to quit smoking', and

'I could quit smoking'. Answers were given on a visual analogue scale ranging from 'completely disagree' to 'completely agree'. The computer program calculated the indicated position on the scale on a range from 1 to 100. We used the same labels and scoring range to measure intention-to-quit measure and receptivity to quitting information.

Stopcoach

At each time point (t_1, t_2 and t_3), we offered participants a web link to a subsequent smoking cessation intervention (iCoach) and asked whether they wanted to see that website (yes / no). iCoach is an online smoking cessation intervention developed by the European Commission (http://stopsmokingcoach.eu).

Secondary outcomes

Cigarettes per day

As smoking reduction may ultimately lead to smoking cessation (Carpenter, Hughes, Solomon, & Callas, 2004; Hughes & Carpenter, 2006), at baseline (t_0), and at each follow-up (t_2 and t_3), we assessed the average number of cigarettes smoked daily. We calculated individual changes in cigarettes per day between t_0 and t_2, and between t_0 and t_3. We also calculated the percentage of participants who reduced their smoking by at least 1 cigarette per day and the percentage of participants who reduced their cigarette consumption by at least 50%. We measured cigarettes per day before the experiment (t_0) and at each follow-up (t_2 and t_3). Cigarettes per day is a variable that cannot change during a 30-min experiment, and we therefore assumed that the number of cigarettes per day directly post-experiment (t1) is the same as at baseline (t0).

Quit attempts

At each follow-up (t_2 and t_3), we asked participants whether they had attempted to quit after the experiment (between t_1 and follow-up). If so, we asked whether they were still abstinent.

Statistical analyses

We compared post-test scores of the experimental intervention with those of the control intervention. We used ANCOVAs to test differences between condition in receptivity to quitting information, intention to quit, quitting self-efficacy, and cigarettes per day. All questionnaires were reliable at each time point (Cronbach's $\alpha > .90$; GLB > .95; $\omega > .90$). We used a chi-square test to test condition differences in Stopcoach visit and quit attempts. Suggested cut-off points for η_p^2's are .01, .06, and .14 for small, medium, and large effects (Cohen, 1988; Olejnik & Algina, 2000). Before conducting the main analyses, we analysed whether selective dropout may have affected our results. We investigated whether those who had dropped out between t_0 and t_1 were different in sex, education, age, years smoked, nicotine dependence, and number of cigarette smoked per day from those who had not (i.e., 'completers'), and whether these differences were different between the two conditions. Between t_0 and t_1, dropouts were more likely to be male (56.2%) than completers (39.0%) in the experimental condition, $\chi^2(1, n = 1{,}324) = 19.51$, $p < .001$, $\varphi = .172$, while among controls, we found no significant difference (45.7% vs. 49.2%), $\chi^2(1, n = 1{,}324) = .75$, $p = .386$, $\varphi = .034$. Also, dropouts in the experimental

condition smoked fewer cigarettes (M = 22.4, SD = 7.0) than completers (M = 23.6, SD = 8.6), while among controls, dropouts smoked more cigarettes (M = 22.3, SD = 6.6) than completers (M = 21.8, SD = 5.5). This interaction was significant,

$F(1, 1{,}324) = 4.85$, $p = .028$, = .004. We therefore controlled the results, where possible, for sex and cigarettes per day.

RESULTS

Sample characteristics

Table 1 shows our sample characteristics. Among those who completed t_1, we found no significant differences between conditions in age, $F(1, 755) = .50$, $p = .481$, $\eta_p^2 = .001$, sex, $\chi^2(1, N = 757) = 3.47$, $p = .062$, $\varphi = .068$, educational level, $\chi^2(1, n = 757) = .02$, $p = .884$, $\varphi = .005$, in years smoked in life, $F(1, 755) = .34$, $p = .559$, $\eta_p^2 < .001$. However, those in the experimental condition were more nicotine dependent than controls, $F(1, 755) = 10.28$, $p = .001$, $\eta_p^2 = .013$ and smoked more cigarettes per day, $F(1, 754) = 12.00$, $p < .001$, $\eta_p^2 = .016$.

[TABLE 1][FIGURE 1]

Results for our main outcomes after the experiment (t_1), after 2 weeks (t_2), and after 2 months (t_3). Error bars reflect standard errors of the mean. [a]Controlled for age, sex, and cigarettes per day.

Receptivity to quitting information

At t_1, those in the experimental condition were significantly more receptive to information about quitting smoking than controls (M = 55.1, SD = 26.1 vs. M = 49.9, SD = 25.4), $F(1, 753) = 11.54$, $p = .001$, $\eta_p^2 = .015$. This difference was no longer present at t_2, $F(1, 574) = 3.00$, $p = .089$, $\eta_p^2 = .005$, or at t_3, $F(1, 482) = .01$, $p = .971$, $\eta_p^2 < .001$.

Intention to quit

We found no significant difference between conditions at t_1 (M = 63.5, SD = 28.2 vs. M = 60.3, SD = 26.6), $F(1, 753) = 3.43$, $p = .064$, $\eta_p^2 = .005$. We also found no significant difference at t_2 (M = 62.6, SD = 28.0 vs. M = 61.4, SD = 27.7), $F(1, 577) = .72$, $p = .397$, $\eta_p^2 = .001$, or at t_3 (M = 61.9, SD = 29.2 vs. M = 65.2, SD = 2.6), $F(1, 489) = .85$, $p = .356$, $\eta_p^2 = .002$.

Quitting self-efficacy

We found no significant difference between conditions at t_1 (M = 52.6, SD = 26.5 vs. M = 52.6, SD = 27.2), $F(1, 753) = .99$, $p = .321$, $\eta_p^2 = .001$, at t_2 (M = 52.1,

SD = 25.9 vs. *M* = 53.6, *SD* = 25.9), $F(1, 576) < .01$, $p = .966$, $\eta_p^2 < .001$, or at t_3 (*M* = 53.3, *SD* = 27.8 vs. *M* = 57.5, *SD* = 26.2), $F(1, 484) = 1.22$, $p = .271$, $\eta_p^2 = .003$.

Stopcoach

Those in the experimental condition did not request the web link significantly more often (*n* = 72, 20.8%) than the controls (*n* = 75, 18.2%) at t_1, $\chi^2(1, N = 757) = .79$, $p = .375$, $\varphi = .032$. We also found no significant difference between conditions at t_2, $\chi^2(1, N = 578) = .010$, $p = .920$, $\varphi = .004$, or at t_3, $\chi^2(1, N = 485) = .79$ $p = .373$, $\varphi = .040$.

Secondary outcomes

[FIGURE 3]

Results for our secondary outcomes after the experiment (t_1), after 2 weeks (t_2), and after 2 months (t_3). Error bars reflect standard errors of the mean. [a]Controlled for age and sex.

Cigarettes per day

At t_2, those in the experimental condition had significantly reduced their smoking (*M* = −1.1, *SD* = 6.2), while controls had not (*M* = 0.3, *SD* = 3.5), $F(1, 596) = 12.00$, $p = .001$, $\eta_p^2 = .020$. Also, more participants in the experimental condition had reduced their smoking by at least 1 cigarette per day (*n* = 60, 22.4%) than in the control group (*n* = 43, 13.0%), $\chi^2(1, n = 599) = 5.90$, $p = .015$, $\varphi = .124$. Similarly, more participants had reduced their cigarette consumption by at least 50% at t_2 in the experimental group (*n* = 13, 4.9%) than in the control group (*n* = 3, 0.9%), $\chi^2(1, n = 599) = 8.848$, $p = .003$, $\varphi = .122$. Although controls also had reduced their cigarette consumption at t_3, the reduction in the number of cigarettes smoked was still significantly larger in the experimental condition (*M* = −1.5, *SD* = 5.1) than among controls (*M* = −0.6, *SD* = 5.0), $F(1, 516) = 4.03$, $p = .045$, $\eta_p^2 = .008$. Again, at t_3, those in the experimental condition had reduced their smoking more often (*n* = 76, 34.1%) than controls (*n* = 73, 24.7%), $\chi^2(1, n = 519) = 5.43$, $p = .020$, $\varphi = .107$. The group difference in the percentage of participants who had reduced their smoking by at least 50% at t_3 was non-significant (*n* = 12, 5.4% vs. *n* = 14, 4.7%), $\chi^2(1, n = 519) = .113$, $p = .737$, $\varphi = .015$.

Quit attempts

At t_2, we found no significant difference in quit attempts between those in the experimental condition (*n* = 10, 3.7%) and controls (*n* = 5, 1.5%), $\chi^2(1, n = 599) = 2.992$, $p = .084$, $\varphi = .071$, and we also found no such difference at t_3 (*n* = 11, 4.9% vs. *n* = 14, 4.7%), $\chi^2(1, n = 519) = .011$, $p = .915$, $\varphi = .005$. We found no significant difference in the number of abstinent participants at t_2 (*n* = 3, 1.1% vs. *n* = 1, 0.3%), $\chi^2(1, n = 599) = 1.491$, $p = .222$, $\varphi = .050$ and no difference at t_3 (*n* = 3, 1.3% vs. *n* = 4, 1.4%), $\chi^2(1, n = 519) < .001$, $p = .995$, $\varphi < .001$.

DISCUSSION

We tested a tailored, brief web-based intervention for hardcore smokers. Immediately after the intervention, participants in the experimental condition seemed more open to information about quitting than controls. They also more often reduced their smoking by at least 50% than controls during the 2 weeks following the intervention. However, as participants only reduced their cigarette consumption by one cigarette per day, the clinical relevance is limited. The intervention proved to be ineffective at changing intention to quit, quitting self-efficacy, quit attempts, or willingness to visit a subsequent intervention.

Receptivity towards information about quitting

The first intervention component was a self-affirmation manipulation, designed to increase participants' receptivity towards information about smoking and quitting. Indeed, participants who completed the intervention were more receptive to quitting information than controls. This corroborates earlier research on this manipulation (Armitage, Harris, Hepton, & Napper, 2008; Bommelé *et al*., 2015b).

Although the intervention increased receptivity to quitting information and reduced the number of cigarettes per day, it did not significantly change intention to quit. This is in line with findings from a recent meta-analysis on the efficacy of self-affirmation manipulation (Epton, Harris, Kane, van Koningsbruggen, & Sheeran, 2015b). The authors identified 144 experimental tests on the efficacy of self-affirmation on message acceptance, intentions, and behaviour. They found that self-affirmation increased message acceptance, intention and behaviour. However, the effect sizes for message acceptance and behaviour were larger than those for intention. Our intervention too had a larger effect on smoking behaviour (η_p^2 = .020) and openess to antismoking information (η_p^2 = .015) than on intention (η_p^2 = .005, ns). The fact that our results showed a similar pattern as those in the meta-analysis on self-affirmation manipulations suggests that the self-affirmation manipulation in our intervention might have been the most effective part of the intervention.

Intention to quit and quitting self-efficacy

The second and third intervention components aimed to increase intention to quit by increasing quitting self-efficacy and by challenging dysfunctional beliefs about smoking and quitting. We found no significant effects on intention to quit and quitting self-efficacy. Because our sample size was substantial, we can be fairly certain that our single-session intervention is not able to change these variables among hardcore smokers.

Future studies might combine this intervention with additional interventions components, such as face-to-face motivational interviews (Miller, 1983; Miller & Rollnick, 2013). In such a case, the online and offline components may together increase intention and quitting self-efficacy, as smokers in the experimental condition did show an increased receptivity to information about quitting smoking.

Reducing cigarette consumption

Participants who completed the intervention had a higher average smoking reduction than controls and more of those in the experimental group reduced their cigarette consumption by at least 50% than among controls. However, the average smoking reduction in the experimental group was only 1 cigarette per day and only about 5% of those in the experimental group reduced their smoking by at least 50%. These results are of limited clinical relevance and do not justify a large-scale

implementation of the intervention in its current form. However, the results from this study may help develop future online interventions for hardcore smokers.
One possible explanation as to why the intervention did not increase intention and self-efficacy, while changing smoking behaviour to a small extent, might be that participating in an intervention about the pros and cons of smoking and smoking cessation changed other factors not measured in our study. The intervention might have made participants more aware of their own beliefs about smoking. This awareness could have been triggered when participants smoked in the weeks following the intervention. On other words, participants may have become more conscious about their cigarette consumption. If future interventions would combine elements from this intervention, it might also refer to those situations in which participants became aware of their cigarette consumption. However, additional research is needed to develop an intervention that would reduce cigarette consumption to clinically relevant level.

Strengths and limitations

One statistical challenge in our study has been the differences in cigarette consumption between the experimental group and the control group at baseline (t_0). Given the randomization procedure, this was not to be expected and it is therefore a matter of contingency. In our study, we first measured cigarettes per day in the screener questionnaire (assessing eligibility, T_0), before randomly allocating participants to either the control or the experimental condition. None of the background variables measured before this randomization had any influence upon the condition the participants were allocated to. Also, our sample size should have been sufficient enough to prevent differences between conditions at baseline. Despite the fact that our randomization reduced the chance of having group differences at baseline to a minimum, such chance can never be ruled out completely. After finding the baseline differences, we controlled for cigarette consumption in every analysis possible and cancelled out effects that could potentially have been caused by the differences in cigarette consumption (and nicotine dependence) at baseline.
Despite the fact that we controlled for age, sex, and cigarettes per day in each analysis, selective dropout may have biased our follow-up data. If in the future this intervention is tested in a randomized controlled trial as part of heath care practice, we believe intention-to-treat analyses are appropriate. For the present stand-alone test, overly conservative estimates due to intention-to-treat analyses might prematurely reject this potentially effective intervention.
A methodological challenge of our study is the fact that not all participants in the experimental condition received the same quality of self-efficacy enhancing information. This self-efficacy enhancing information was presented in a series of video clips in which an ex-smoker discussed specific ways to prevent relapse after quitting. Although the situations were the same for all participants, the actors in the video clips matched the participants' gender and socio-economic status. Men, for example, watched video clips of male actors, while women watched videos clips of female actors. As some actors may have been more credible than others, the video clips may not have been similarly convincing for all four subgroups.
A strength of our study is the use of a control intervention that was similar in design and layout to the experimental intervention. The only differences between the experimental condition and the control condition were the content and the combination of techniques used. In the experimental condition, we used tailored

messages, motivational interviewing techniques, and a self-affirmation manipulation. We did not use these techniques in the control intervention. This way, we can be certain that the differences between conditions have been caused by this combination of techniques and content only (de Bruin, Crutzen, & Peters, 2015; Peters, de Bruin, & Crutzen, 2015).

Practical implications

While there are many web-based interventions available for smokers (Civljak *et al*., 2013; Walters *et al*., 2006), our intervention is, as far as we know, the first online intervention designed especially for hardcore smokers. Although the long-term effects of our intervention are unclear, it seems to increase receptivity to quitting information in the short term. It does not, however, increase hardcore smokers' self-efficacy or intention to quit.

Health professionals (e.g., GP's, physiotherapists, medical specialists) play an important role in tobacco control. They often encounter hardcore smokers and have shown to be able to effectively motivate some of these smokers to quit smoking (Omaña-Cepeda, Jane-Salas, Estrugo-Devesa, Chimenos-Kustner, & Lopez-Lopez, 2015; Stead *et al*., 2013). However, few hardcore smokers are willing to quit smoking. Many health professionals are reluctant to discuss smoking cessation, because they fear it might damage their relationship with the patient (Coleman, Murphy, & Cheater, 2000).

Our intervention may help both hardcore smokers and health professionals in such cases. Health care professionals could offer our intervention to hardcore smokers as an introduction to a next consult. These smokers then complete this intervention at home, before their next consult. As the current intervention does not require face-to-face interaction with a health professional, smokers may feel less threatened by the antismoking information. After completing the intervention, smokers might have become more receptive for and willing to discuss smoking cessation during the next visit to the health professional. However, this increase in receptivity is only temporary and may not last much longer than a week. Psychotherapists, physiotherapists, and other health professionals who see their patients on a weekly or biweekly basis may use this intervention as a way to reduce hardcore smokers' defensive responses towards information about quitting. Health professionals who want to involve resistant hardcore smokers in tobacco control and who see their patients regularly could use this intervention as a low-cost introduction to a face-to-face conversation about smoking cessation.

The intervention may be less suitable for patients of health professionals who do not see their patients regularly. If such health professionals would use this intervention as a standalone e-health intervention with little face-to-face support, the intervention is not expected to lead to clinically relevant changes in smoking. But as a tool for assisting health professionals in the short term, it might be helpful in reaching and involving resistant hardcore smokers in tobacco control.

Final conclusions

The intervention increases hardcore smokers' receptivity to information about quitting. It also helps to reduce smoking by about one cigarette per day. However, it proved to be ineffective at increasing hardcore smokers' quitting self-efficacy, intention to quit or quit attempts. The results therefore do not warrant an immediate large-scale implementation as a standalone intervention. However, future research

might investigate ways health professionals could use this intervention as a first step to involve hardcore smokers in tobacco control.

AUTHOR CONTRIBUTIONS

All authors designed the study. JB, TS, and GJP conducted the statistical analysis. JB wrote the first draft of the manuscript, and all authors contributed to and have approved the final manuscript.

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CONFLICT OF INTEREST

None to declare.

Ancillary

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TABLES AND FIGURES

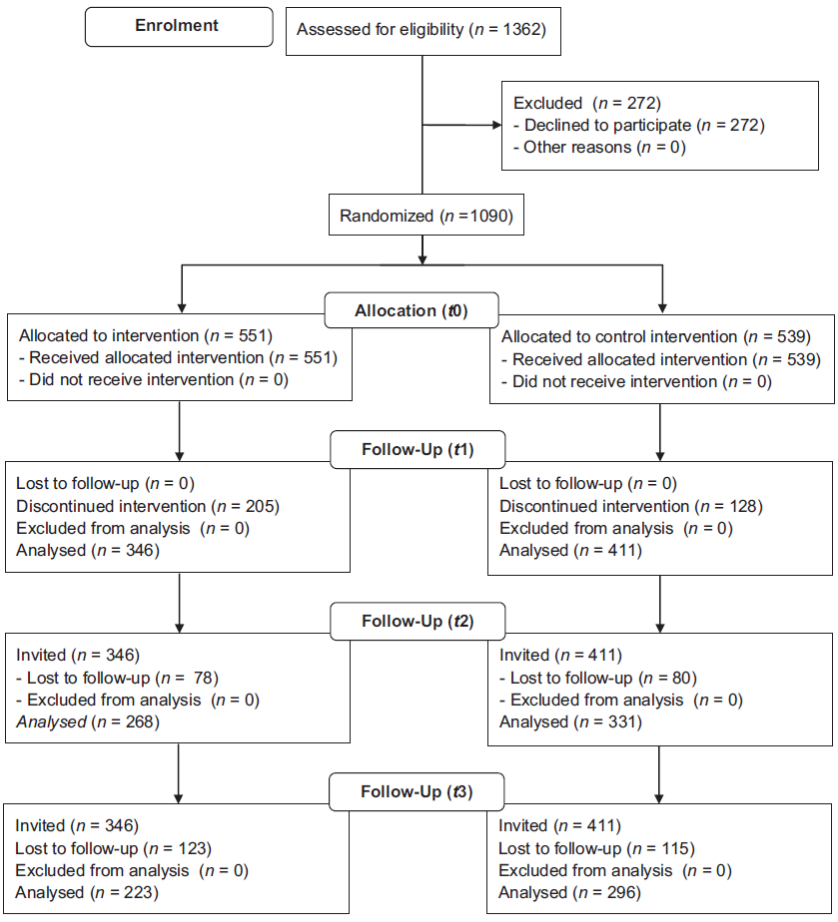

Figure 1. Flow diagram of recruitment and progress throughout the study.

Table 1. Sample characteristics at t_1

	Intervention	Controls	Significance
Sample size	346	411	
Age (*SD*)	49.0 (10.4)	48.5 (10.3)	$p = .481$
Sex			
Male	135 (39.0%)	183 (44.5%)	$p = .062$
Female	211 (61.0%)	228 (55.5%)	
Education			
Low	256 (74.0%)	306 (74.5%)	$p = .884$
High	90 (26.0%)	105 (25.5%)	
Years smoked in life (*SD*)	31.9 (11.1)	31.4 (10.9)	$p = .559$
Nicotine dependence (*SD*)[a]	6.1 (1.8)	5.6 (1.8)	$p = .001$
Cigarettes per day	23.6 (8.6)	21.8 (5.5)	$p = .001$

Note. [a]Fagerström Test for Nicotine Dependence.

Figure 2. Results for our main outcomes after the experiment (t1), after 2 weeks (t2), and after 2 months (t3). Error bars reflect standard errors of the mean. aControlled for age, sex, and cigarettes per day.

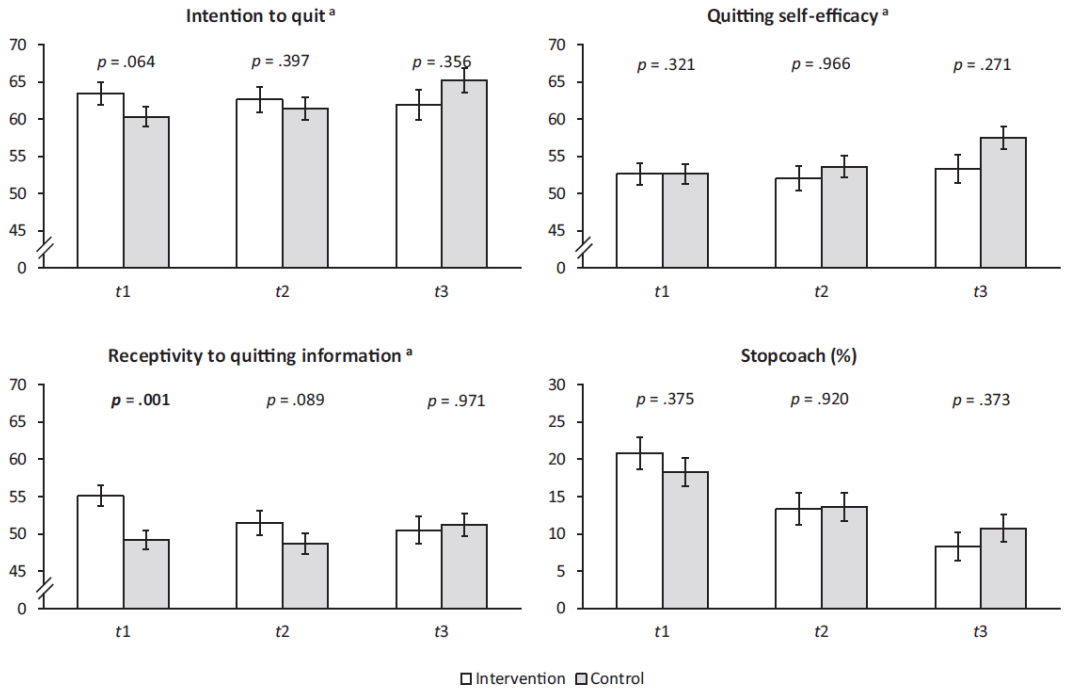

Figure 3. Results for our secondary outcomes after the experiment (t_1), after 2 weeks (t_2), and after 2 months (t_3). Error bars reflect standard errors of the mean. [a]Controlled for age and sex.